MASTER

XVII.

The Climatic Aspects of Horticulture in the West Midland Region

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This memorandum was prepared as part of a Report on the Potential Horticultural Areas in the West Midland Region, i.e. over the counties of Cheshire, Shropshire, Staffordshire, Warwickshire, Worcestershire and Herefordshire. It is directed to those interested in horticulture rather than to meteorologists. The object of the full Report was to assess areas which appear to be of potential horticultural value and any allusion to grades in the text refer to this assessment.

The West Midland Region is almost entirely inland; it also lies in the lee of the Welsh mountains and these two facts have important climatic consequences. Spring temperatures are somewhat low, the risk of frost is high, and very early production is for the most part impracticable. However, the use of modern aids such as polythene houses, mobile glasshouses and special kinds of frames and structures to some extent offset the low spring temperatures. The average rainfall is less than 30 inches over most of the region and in many years the water needs of shallow rooted crops are not met. In many areas irrigation must be regarded as almost essential, unless the soils are particularly retentive. The only area where there is any perceptible marine influence is in Cheshire, where frost is less likely near the coast. It is, however, unlikely that the irrigation needs are markedly less in this district. Wind can be a serious problem on the Wirral but elsewhere there is usually sufficient natural shelter to allow reasonable crop growth. In some districts, however, yields could probably be increased by the provision of extra shelter. The inland location also leads to a reduction in sunshine; this is most marked in winter and is accompanied by pollution near some of the large industrial towns.

Temperature

The following table summarizes the temperature over the region. Values for Penzance are also given for comparison.

Monthly averages of maximum, minimum and mean temperature (°F), 1921-50

	Ross-on-Wye 223 ft.			Leamington Spa 163 ft.			Bidston 198 ft.			Penzance 55 ft.		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Jan.	44.4	36.3	40.4	44.5	34.2	39.3	44.0	35.9	40.0	49.6	41.3	45.5
Feb.	45.3	35.8	40.6	45.2	34.5	39.8	44.0	35.9	40.0	49.4	40.7	45.1
Mar.	50.4	36.8	43.6	50.6	36.1	43.4	47.9	37.8	42.8	52.0	41.9	47.0
Apr.	55.2	40.1	47.7	55.5	39.9	47.7	52.2	41.5	46.8	55.2	44.0	49.6
May	61.3	44.4	52.9	61.7	44.4	53.1	58.2	45.9	52.1	60.0	47.8	53.9
June	67.1	49.9	58.5	67.5	50.3	58.9	63.1	51.3	57.2	65.0	52.5	58.8
July	69.8	53.6	61.7	70.6	54.1	62.3	65.9	54.9	60.4	67.3	55.6	61.5
Aug.	69.0	52.9	60.9	69.7	53.2	61.5	65.2	54.5	59.9	67.7	55.8	61.7
Sept.	64.6	49.7	57.1	65.0	49.6	57.3	61.3	51.5	56.4	64.7	53.6	59.1
Oct.	56.9	44.3	50.6	57.2	43.8	50.5	54.8	45.9	50.4	59.2	49.2	54.2
Nov.	49.0	39.9	44.5	49.4	38.4	43.9	48.4	40.5	44.4	53.9	44.7	49.3
Dec.	44.7	37.2	41.0	44.8	35.2	40.0	44.9	37.5	41.2	50.5	41.9	46.2
Year	56.5	43.4	49.9	56.8	42.8	49.8	54.2	44.4	49.3	57.9	47.4	52.7

The average maximum and minimum temperatures for Leamington Spa and Penzance are shown in Fig. 1. These curves suggest that nights are warmer in Cornwall than in the Midlands throughout the year, but that the Midland day temperatures are higher than those for Cornwall from April or May to August or

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September. In winter (Dec.-Feb.) the nights are about 7° colder in the West Midlands than in the S.W., but in summer (June-Aug.) the difference is only about 2-3°. Along the Cheshire coast nights are a degree or two warmer than inland, but they are considerably cooler than in Cornwall. The effect of a maritime location is felt mainly in very cold periods; for example, in February 1956 the minimum temperature recorded in the Wirral was some 10° higher than in Shropshire. On average, the West Midlands are about a degree warmer than the horticultural districts in the East Midlands and the Eastern Region; the effect of any such difference is important during spring nights. On still clear nights the difference will sometimes amount to several degrees.

The cool nights in winter and spring lead to a fairly high risk of frost in the West Midlands. A frost is said to occur when the air temperature at a height of about 4 feet above ground level falls to freezing point, irrespective of whether or not there are any visible signs of frost. In general, frosts are more frequent and more severe inland than near the coast. The liability to frost depends so much on local factors of air drainage that it is difficult to generalize over a large area. On the whole, however, it seems that the lower lying sites in the West Midlands experience the first autumn frost in late September or early October on average. In favoured areas this may be delayed until November, e.g., Bidston (near Birkenhead) with its maritime location, Malvern with a favourable topography and Edgbaston where the effects of favourable topography are probably reinforced by an urban effect. In spring, most places have their last frost on average in the first half of May but in favoured areas it is in April or even late March. In the following table the values for Penzance are given for comparison, and it can be seen that in many places the average frost-free period is four months shorter than in South West England. Because of the liability to spring frosts, none of the West Midland Region can be put into Grade I for fruit.

Average and extreme dates of first and last frosts

		First frost		Last frost	
Place	Period	Average	Extreme	Average	Extreme
Ross-on-Wye	1915-40	19/10	24/9	26/4	31/5
Hereford	1912-40	12/10	8/9	2/5	26/6
Bromyard	1911-40	30/9	31/8	10/5	5/6
Malvern	1912-40	15/11	19/10	3/4	14/5
Worcester	1926-40	6/10	8/9	6/5	31/5
Tenbury	1917-28	26/9	3/9	9/5	5/6
Leamington Spa	1913-40	18/10	29/9	28/4	27/5
Rugby	1911-40	15/10	28/8	2/5	1/6
Edgbaston	1911-40	9/11	18/10	12/4	17/5
Cheadle	1915-26	20/10	29/9	2/5	19/5
Shrewsbury	1911-18: 29/40	4/10	8/9	6/5	31/5
Newport	1928-40	5/10	8/9	8/5	5/6
Macclesfield	1912-40	24/10	20/9	4/5	30/5
Sealand	1922-40	15/10	21/9	2/5	28/5
Bidston	1911-40	22/11	24/10	23/3	17/5
Penzance	1911-40	12/12	26/10	5/3	7/4

When using this table, two points need to be remembered. The first is that the extreme dates become more extreme as the period of observations is increased, and the second is that on the whole, the data refer to reasonably well-exposed sites; there are no doubt some areas where poor air drainage will result in a shorter frost-free period. On the other hand, individual fields on middle slopes with a southerly aspect will have longer periods free of frost.

The lateness of the region compared with the more maritime areas of S.W. England is shown in the following table, which gives the accumulated number of degree-days above 42°. The values in this table take account of the amount by which the temperature exceeds 42° and also of the period during which it is above 42°. For example, a temperature of 52° for 1 day counts as 10 degree-days, as does also a temperature of 47° for 2 days or 43° for 10 days.

	Ross-on-Wye	Birmingham	Bidston	Penzance	Worthing
Jan.	108	83	85	147	103
Feb.	99	79	67	127	88
March	108	96	98	164	105
April	186	175	159	228	191
May	335	332	307	369	357
June	495	498	456	504	513
July	611	623	570	605	635
Aug.	586	592	555	611	639
Sept.	453	447	432	513	522
Oct.	267	248	260	375	338
Nov.	120	96	108	222	154
Dec.	92	68	82	158	97
Year	3,460	3,337	3,179	4,023	3,742

The totals for the winter half-year (October-March inclusive) are of most interest in relation to earliness. At Ross the total is 794, at Birmingham 670 and at Bidston 700. These values are considerably less than in the South-west (1,193 at Penzance); some maritime influence can be seen in the figures for Bidston, compared with Birmingham, but for heating glass this advantage is probably discounted by greater windiness.

The accumulated number of degree-days below 60° can be used to indicate heating requirements for glass, assuming that the inside temperature is not allowed to fall below 60°. Values are given below for the West Midlands and for Penzance.

	Ross-on-Wye	Birmingham	Bidston	Penzance
Jan.	608	660	620	449
Feb.	548	587	565	421
March	508	542	533	403
April	369	384	399	312
May	226	229	251	189
June	79	84	103	69
July	49	47	60	43
Aug.	51	56	65	43
Sept.	112	120	123	75
Oct.	291	313	298	183
Nov.	465	501	465	321
Dec.	589	636	583	428
Year	3,895	4,159	4,065	2,936

The number of degree-days for the period of heating for individual crops are as follows:-

	Ross-on-Wye	Birmingham	Bidston
Tomatoes	3,300	3,520	3,400
Cucumbers	3,590	3,830	3,730
Lettuce	2,980	3,200	3,050
Chrysanthemums	2,640	2,830	2,670

These figures are based on the following assumed dates for heating in the West Midlands: tomatoes Nov. 4th to June 7th; cucumbers Oct. 15th to July 31st; lettuce Nov. 11th to May 4th; chrysanthemums Nov. 4th to March 28th. Roughly, 10 degree-days can be taken as equivalent to 1 ton of coal per acre of glass.

On this basis, heated houses in the central part of the West Midland Region need an extra 20-25 tons per acre of glass for these crops, as compared with the South-west of the Region. In comparison with sheltered parts of Cornwall, growers in the West Midland Region need 80-100 tons per acre more coal for simila heated crops. It may therefore be more economic to concentrate on efficient cold houses for early summer production than to attempt early spring production.

Sunshine

Sunshine in the British Isles usually decreases with distance from the sea, with altitude and with latitude. Monthly averages for Leamington Spa, Hoylake and Worthing are given in Fig.1. The mean duration of sunshine over the whole year is over 4 hours per day in the south of the region and in the Wirral. Inland it falls to about 3½ hours per day, but some of this loss may be due to the effect of industrial smoke. The most favoured parts of the region for winter sunshine are in the south, where there is a total of 450-475 hours over the period October to March, compared with about 350 hours in central districts and 400-425 hours in the Wirral. In the Worthing district the corresponding value is about 560 hours.

Although no light records are available, there must be a good deal of pollution near industrial areas. One effect of this is to reduce the transmission of light because of solid material suspended in the air. As the solid material settles on glass it accumulates and the reduction of light intensity will become progressively greater if the glass is not frequently cleaned. Also, plants growing in houses or outside are sensitive to atmospheric smoke and sulphur dioxide and pollution may be responsible for large reductions in yield. Much of Cheshire and parts of Staffordshire, North Warwickshire and North Worcestershire are likely to suffer most from the effects of pollution. Herefordshire is probably the county with the cleanest air in the region.

Wind

The only very windy part of the region is in the Wirral, where the privet hedges giving protection to horticultural crops are a feature of the landscape near the coast. In these more exposed areas, the mean wind-speed is about 13 m.p.h., but in the lee of the Welsh mountains it certainly falls below 10 m.p.h. Corresponding to this general decrease in wind-speed the number of days with a gale (39 m.p.h. or more) decreases from about 12 a year along the coast of the Wirral to 2 or less inland. The contrast between these areas is brought out by the following table, which gives the average number of days with gusts of 39 m.p.h. or more. Not all of these would count as a gale, which is a period of some 10 minutes or more with a mean speed of 39 m.p.h. or more.

	Bidston	Birmingham
Jan.	14.1	7.6
Feb.	12.9	6.4
Mar.	11.3	4.4
April	8.7	4.7
May	3.9	2.6
June	5.3	1.3
July	6.6	2.0
Aug.	6.1	1.7
Sept.	4.9	1.0
Oct.	10.7	5.1
Nov.	10.9	5.0
Dec.	15.0	8.0
Year	110.3	49.9

At Bidston, a mean hourly wind-speed of at least 60 m.p.h. can be expected once in 20 years, but at Birmingham the corresponding value is only 40 m.p.h.

Rainfall

The region lies in the rain-shadow of the Welsh mountains and the rainfall reaches 40" in only a few upland districts, mainly in the Pennines of East Cheshire. In most areas of horticultural interest, the rainfall is 25-30". On the whole it tends to be nearer to 25" in the south and to 30" in the north, but there are local variations which make it difficult to generalize.

The average monthly rainfall (1916-50) in inches is given below for a selection of stations in or near areas of potential horticultural interest.

	Hereford	Worcester	Leamington Spa	Shrewsbury	Newport	Stafford	Bidston
Jan.	2.58	2.56	2.22	2.39	2.35	2.87	2.56
Feb.	1.78	1.70	1.70	1.70	1.75	2.14	1.93
Mar.	1.77	1.58	1.57	1.62	1.64	1.89	1.64
Apr.	1.79	1.88	1.90	1.85	1.79	1.98	1.69
May	2.16	2.37	1.98	2.10	2.18	2.32	2.26
June	1.65	1.56	1.62	1.73	1.73	2.04	1.98
July	2.28	2.33	2.43	2.40	2.65	2.93	2.77
Aug.	2.42	2.31	2.25	2.50	2.53	2.77	3.13
Sept.	2.27	2.14	2.17	2.14	2.18	2.43	2.63
Oct.	2.69	2.38	2.31	2.65	2.69	2.94	3.01
Nov.	2.71	2.51	2.42	2.47	2.49	2.86	2.78
Dec.	2.30	2.21	2.03	2.20	2.12	2.62	2.63
Year	26.40	25.53	24.60	25.75	26.10	29.79	29.01

The diagrams in Fig. 3. show that the main feature of the distribution is the comparatively dry period from February to June and particularly from February to April. During the period February to April, only about one-fifth of the annual rainfall can be expected; this amounts to 5 or 6" in most places. After a comparatively wet May, June is another dry month on average and about one-third of the annual rainfall can be expected from February to June, i.e., some 9 to 10" in most places. The wettest period tends to be in October and November when about one-fifth of annual total can be expected on average, i.e., 5 to 6". Towards the north of the region July and August may well be the wettest months.

There is, of course, wide variation in the amount of rain which falls in any given month, and the rainfall variation diagrams for the period 1916-50 in Fig. 2. give an indication of this. In these diagrams the white dots represent the median rainfalls. The median is the value which has an even chance that the rainfall will occur above or below it: for example the Bidston value for January is 2.5" and in any January the rainfall is equally likely to be above or below 2.5". The black dots are the extreme rainfalls recorded during the period 1916-50 and the black areas show the central 50% of recorded rainfalls. Thus at Bidston there is an even chance that the January rainfall will lie between 1.5 and 3.5". The size of the black area is smallest when the rainfall is least variable and greatest when it is most variable. On the whole, rainfall is least variable in the comparatively dry spring months and most variable in autumn.

The tendency for rather dry weather in spring and early summer may be an advantage to many horticultural crops in some years, but in other years the water needs of the growing crops may considerably exceed the rainfall. The following water needs have been calculated for a period of 20 years, assuming that the soil deficit should not be allowed to fall far below 1" for the general run of horticultural crops (see Fig. 3). For bush and cane fruits, a larger soil moisture deficit could be allowed and the irrigation needs would not be so great.

Number of years in 20 when the irrigation needs exceed stated amounts

Irrigation needs (inches)	0	2	4	6	8
Ross-on-Wye	20	19	15	10	4
Malvern	19	19	12	7	1
Leamington Spa	20	19	11	8	4
Birmingham	20	16	10	5	0
Shrewsbury	19	19	14	5	2
West Kirby	20	18	10	3	2

On these values, there seems no doubt that irrigation would be a decided advantage, if not a necessity, for the maximum production of shallow-rooted crops and this is an important reason why there are no Grade I areas for vegetable production in the West Midlands. It is, of course, true that on the best soils the need for irrigation would be felt rather less because of the more retentive nature of the soil. Although these irrigation needs are high, they are less than in most of the eastern half of England.

Humidity

Long periods of high relative humidity and warm weather are often associated with plant disease, e.g., potato blight and apple scab. Owing to the inter-relation between relative humidity and temperature it is difficult to generalize on humidity, but there is no doubt that the air over the central part of the region is made drier by its passage over the Welsh mountains when westerly winds are blowing. Relative humidity in the middle of the day during summer is likely to be 5-10% lower inland than in the Wirral; in winter there is much less difference.

The following table gives the mean Relative Humidity at 1300 G.M.T. for three places in the region:-

Period	Ross-on-Wye 1921-35	Birmingham 1923-35	Bidston 1922-34
Jan.	79	82	82
Feb.	74	77	78
Mar.	66	67	71
Apr.	63	66	68
May	63	63	68
June	61	63	68
July	62	65	72
Aug.	65	65	73
Sept.	68	68	72
Oct.	72	73	75
Nov.	77	80	81
Dec.	79	84	84
Year	69	71	74

Recent work has shown that there is a great deal of variation in the incidence of high humidity. Most places on the plain have an average of 3,000-3,500 hours a year with relative humidity 90% or more, but some places have only 2,000 hours and others about 4,000. These differences appear to be due to local differences in exposure to moist winds.

Meteorological Office,
National Agricultural Advisory Service,
Bristol.

Agricultural Memorandum No. XVII.

October 1958.

G.1226/KEC/10/58/50

ADDENDA

HUMIDITY

Long periods of high relative humidity during warm weather are often associated with plant diseases, e.g., potato blight and apple scab. Relative humidity depends on both the amount of water vapour in the air and on the temperature, so that much care is needed in interpreting the data. The following tables give the average monthly relative humidity at three places in the Region, based on readings at 0300, 0900, 1500 and 2100 G.M.T. The Plymouth values are also given for comparison.

MONTHLY AVERAGES OF RELATIVE HUMIDITY (PERCENT)

	Birmingham (Elmdon)	Shawbury	Manchester	Plymouth
Period	June '49-May '59	1946-58	1945-58	1945-58
Jan.	87	85	87	86
Feb.	86	84	84	85
Mar.	82	81	79	83
Apr.	77	75	74	79
May	77	75	74	80
June	77	76	77	83
July	79	77	79	83
Aug.	81	79	80	85
Sept.	83	81	81	87
Oct.	87	84	84	87
Nov.	89	86	86	86
Dec.	89	87	87	87
Year	83	81	81	84

The annual values are very similar at the coastal and inland stations, but the inland stations are considerably less humid during the summer months, which are of most importance in relation to disease. The hourly values show that the diurnal variation in the summer is considerably greater inland than near the coast, which implies that the chances of a spell of high humidity are less inland than along the coast. The June values are given below as an example.

JUNE AVERAGES OF RELATIVE HUMIDITY AT STATED TIMES (PERCENT)

Time (G.M.T.)	Ross-on-Wye	Birmingham (Elmdon)	Shawbury	Manchester	Plymouth
0300	-	91	89	89	91
0900	74	77	74	75	80
1500	62	63	62	63	74
2100	78	79	78	79	85
Range	-	28	27	26	17

Recent work has shown that most places on the plain have an average of 3,000 - 3,500 hours a year with relative humidity 90% or more, but some places have only 2,000 hours and others about 4,000. These differences appear to be due to local differences in exposure to moist winds.

Earth Temperature

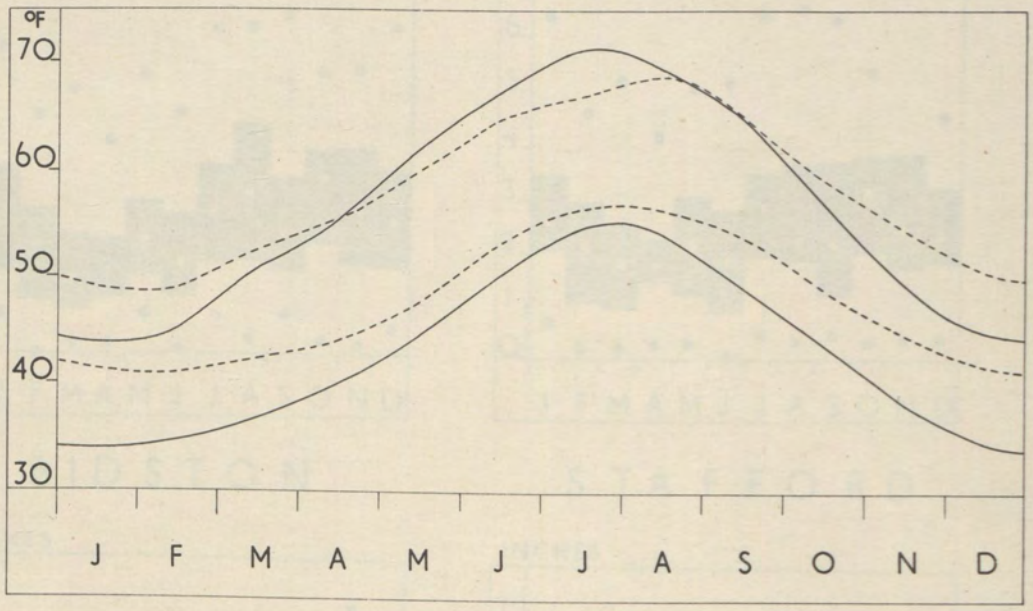
The following table gives computed long period normals of earth temperature at a depth of 1 foot. The values for Falmouth are given for comparison.

Monthly Normals of Earth Temperature at 1 ft. depth (°F)

Station	Ross-on-Wye	Malvern	Leamington	Codsal	Shrewsbury	Sealand	Falmouth
Altitude (ft)	223	380	163	409	184	16	167
Soil	Sand over red s'stone	red marl and gravel	Clay	Loam	sand and gravel	sandy loam over sand	light sandy
Jan.	39.9	38.7	38.8	39.5	40.1	40.4	44.2
Feb.	39.9	38.5	39.1	38.6	39.9	40.1	44.2
Mar.	42.3	41.1	42.4	40.7	42.1	42.0	46.4
Apr.	47.7	47.2	49.3	45.2	47.4	46.8	51.2
May	53.9	53.5	56.6	51.1	53.4	52.3	56.5
June	60.1	60.1	63.5	57.2	59.5	57.9	61.8
July	63.2	63.3	66.1	60.1	62.5	60.7	64.3
Aug.	62.5	62.5	65.0	59.7	61.7	60.6	64.2
Sept.	58.8	58.6	60.3	56.7	58.6	57.2	61.5
Oct.	52.1	51.5	52.4	50.0	52.4	51.7	55.9
Nov.	45.4	44.5	44.6	44.5	45.6	45.8	49.5
Dec.	41.3	40.3	40.0	40.9	41.7	42.0	45.6
Year	50.6	50.0	51.5	48.6	50.4	49.8	53.8

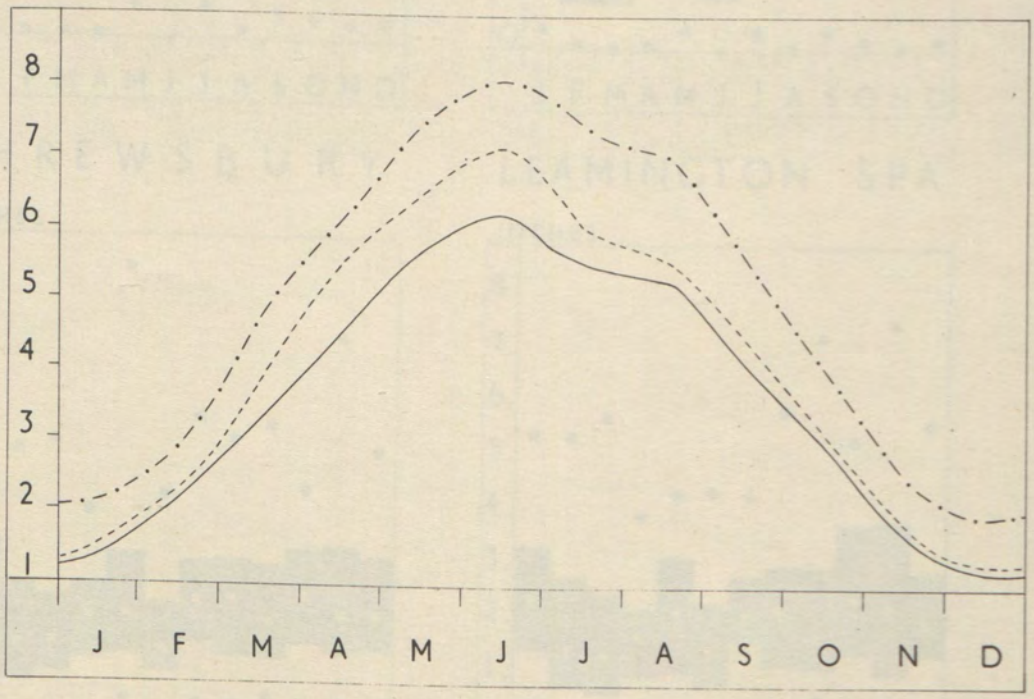
Differences in altitude and aspect and soil type make detailed analysis of earth temperatures difficult, but the coolness of the soil compared with South West England is apparent. The differences are particularly marked in winter when the average temperature is some 4° to 6°F lower than in the South West. This tendency persists throughout spring and is an important factor in horticulture as it precludes early production for two reasons, viz. the slowness of germination on account of low temperatures, and the risk of late spring frosts.

MONTHLY AVERAGES OF MAXIMUM & MINIMUM TEMPERATURES



LEAMINGTON SPA PENZANCE

AVERAGE HOURS OF SUNSHINE PER DAY



HOYLAKE LEAMINGTON SPA WORTHING

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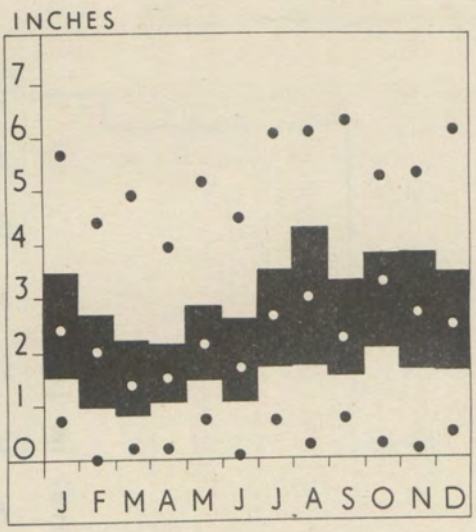
Fig. 2.

RAINFALL VARIATION DIAGRAMS



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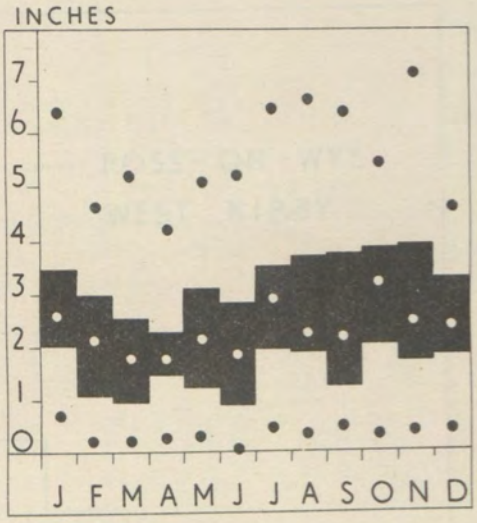

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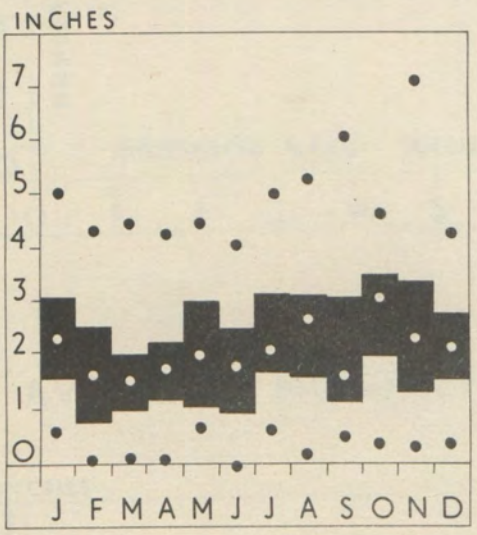

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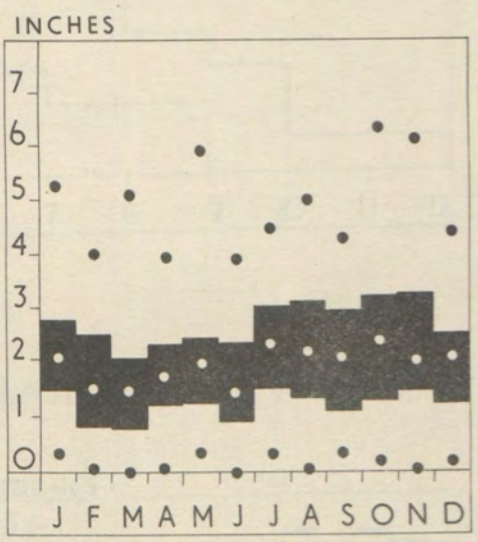
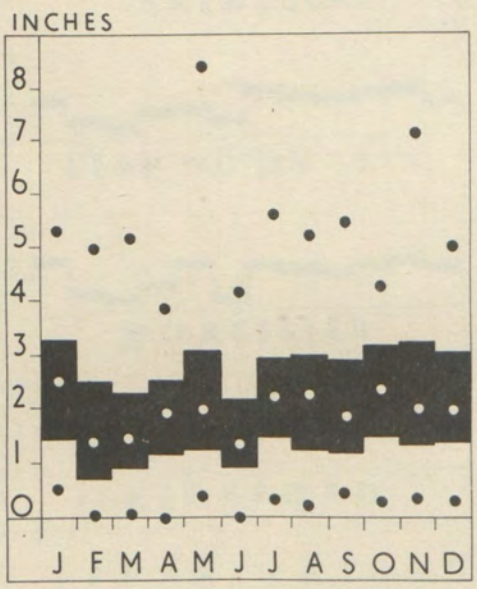
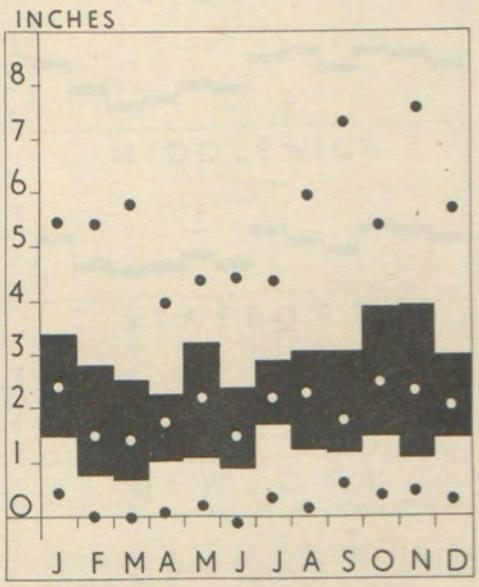


LEAMINGTON SPA



WORCESTER



HEREFORD

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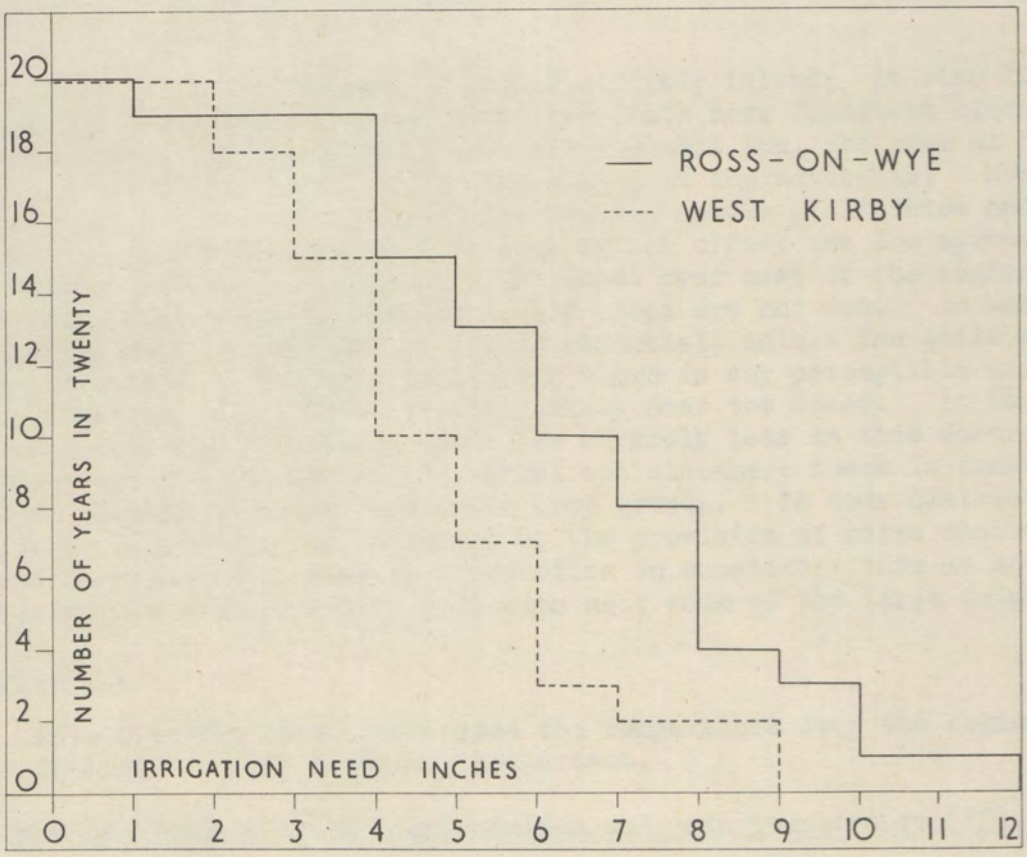
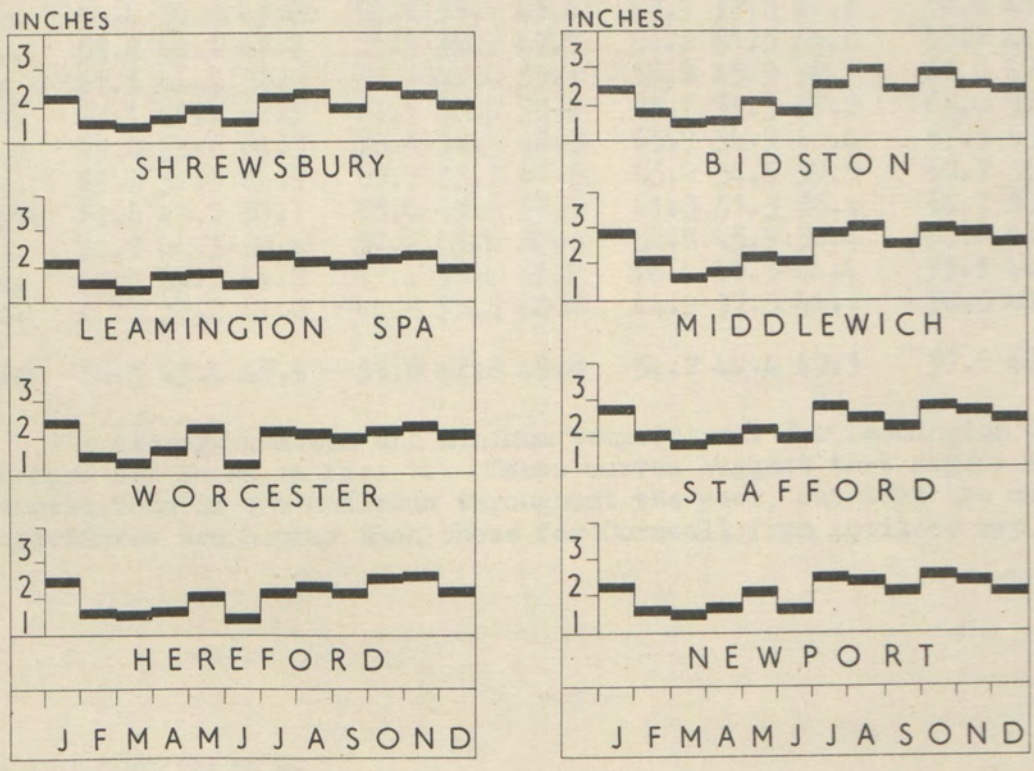
Fig. 3.

IRRIGATION NEED

1" SOIL MOISTURE DEFICIT



AVERAGE MONTHLY RAINFALL 1916-50



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